Japanese Institutions in PHENIX

Center for Nuclear Study (CNS-Tokyo), University of Tokyo

Hiroshima University

KEK - High Energy Accelerator Research Organization

Kyoto University

Nagasaki Institute of Applied Science

RIKEN

RIKEN/BNL Research Center

Physics Department, Rikkyo University

Tokyo Institute of Technology

University of Tsukuba

ePHENIX

Dave Morrison
for the PHENIX Collaboration

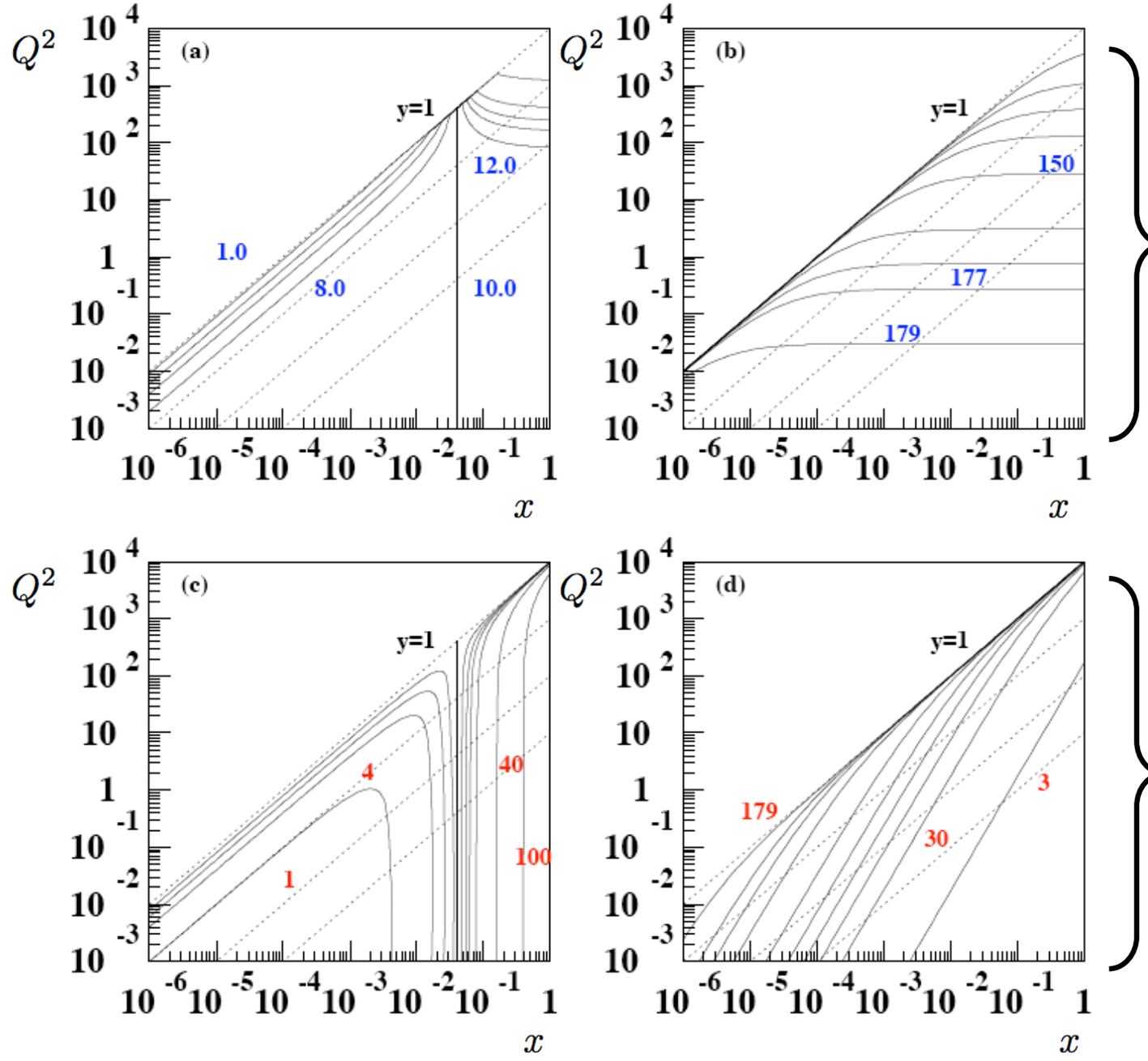
(ep)HENIX

Dave Morrison
for the PHENIX Collaboration

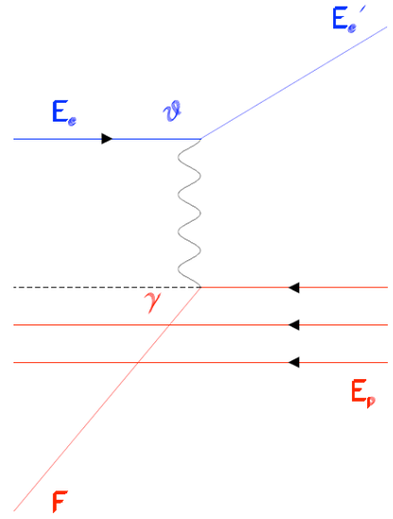
ep QCD collider program

- Event kinematics (10GeV electron on 250GeV proton)

Lines of constant electron energy (E'_e)

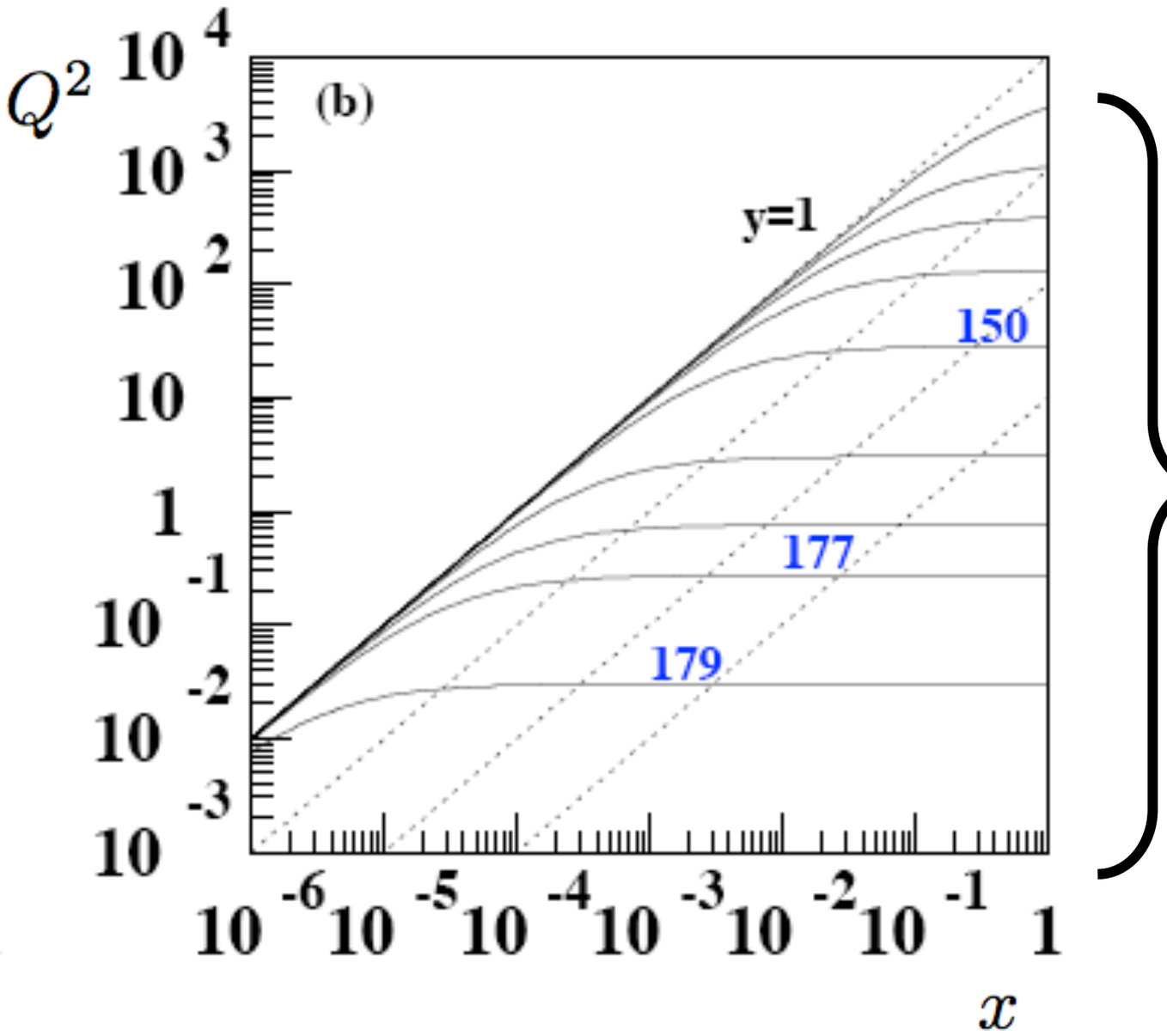


Lines of constant electron angle (ϑ'_e)

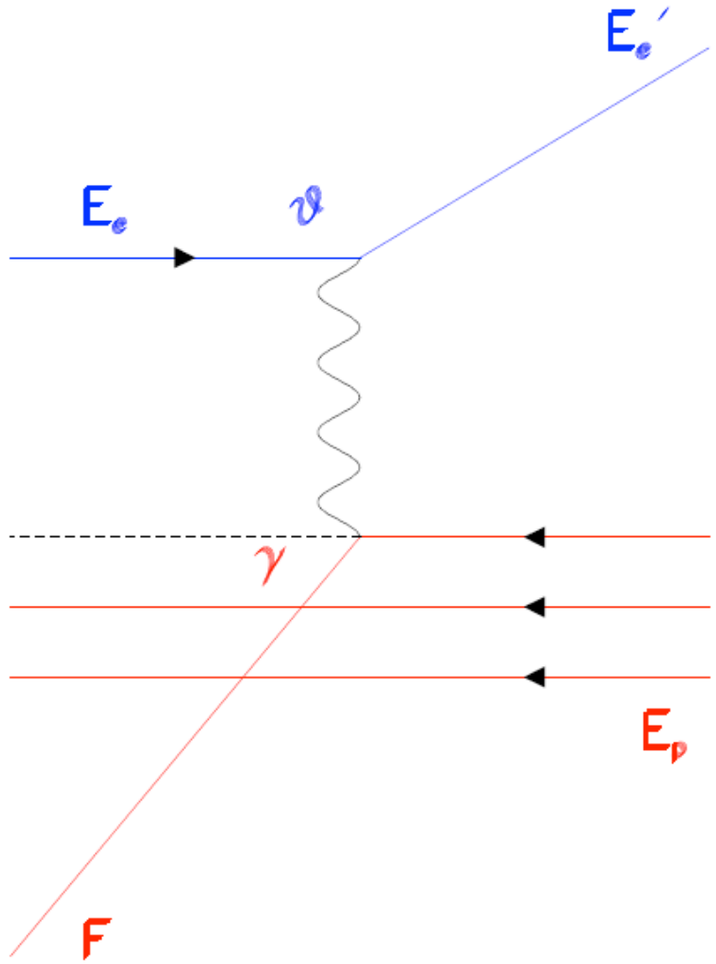


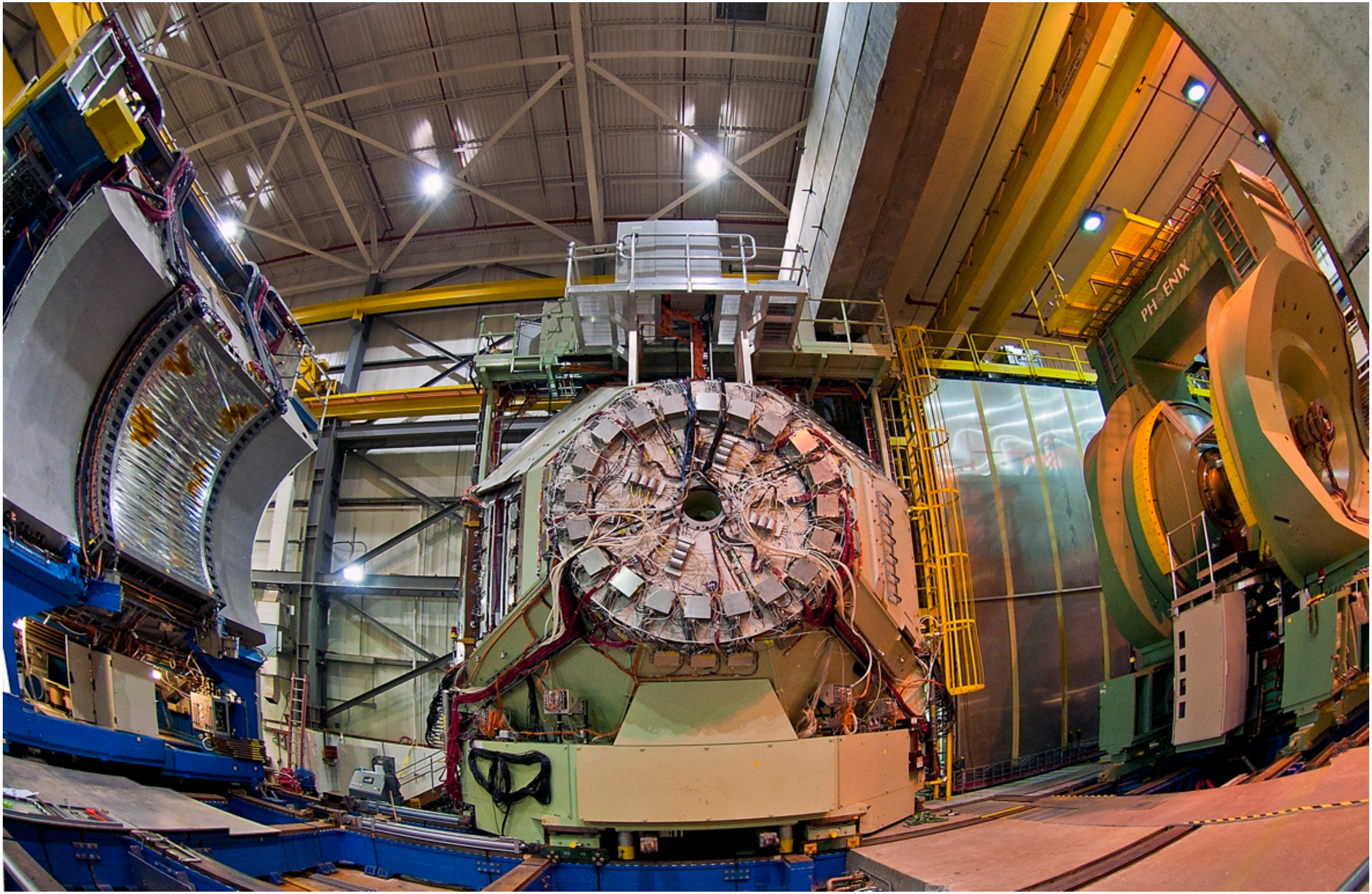
Lines of constant hadron energy (F)

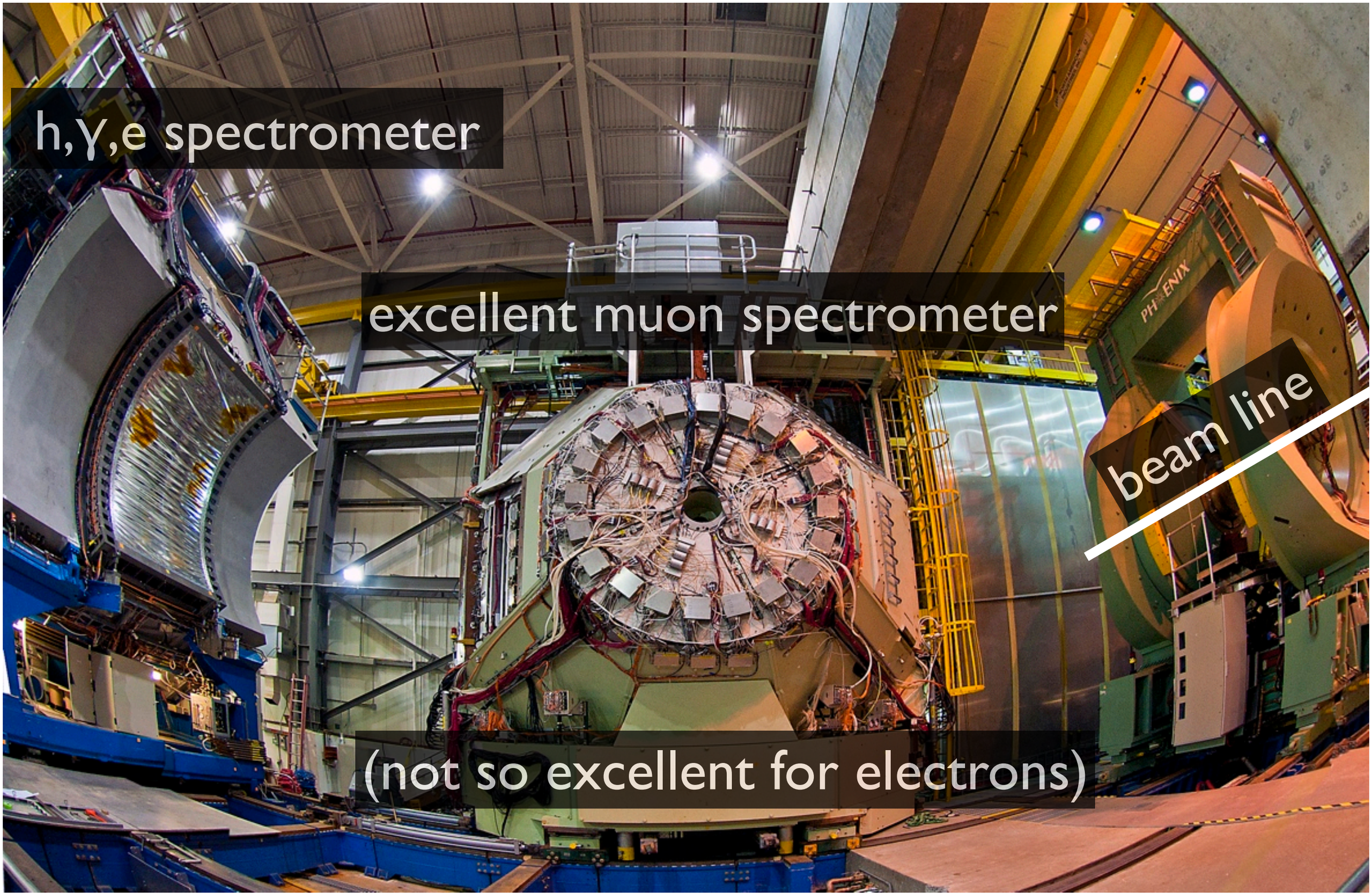
Lines of constant hadron angle (γ)

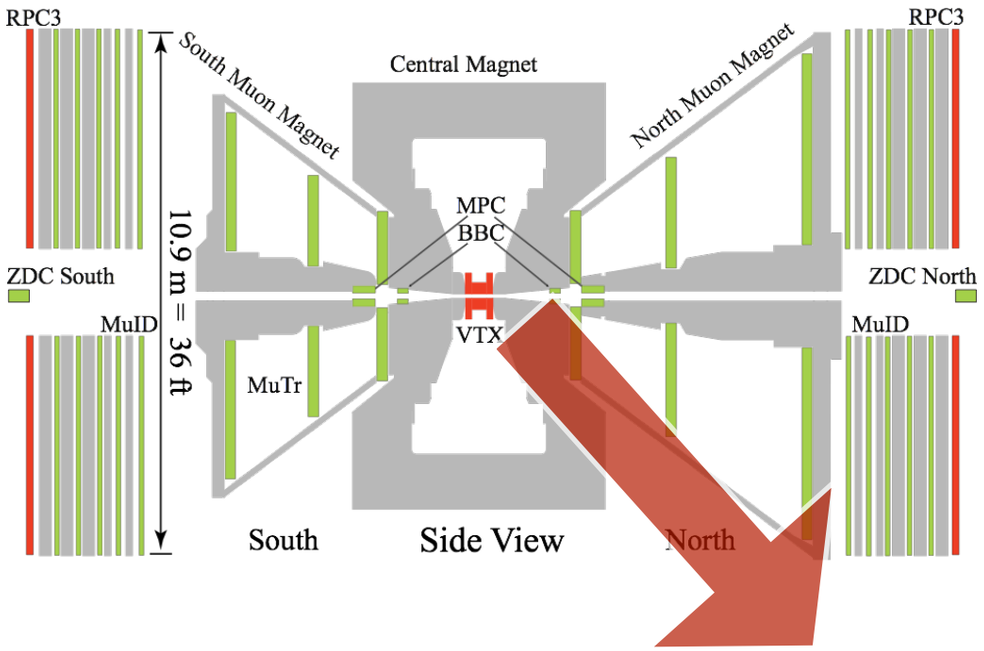


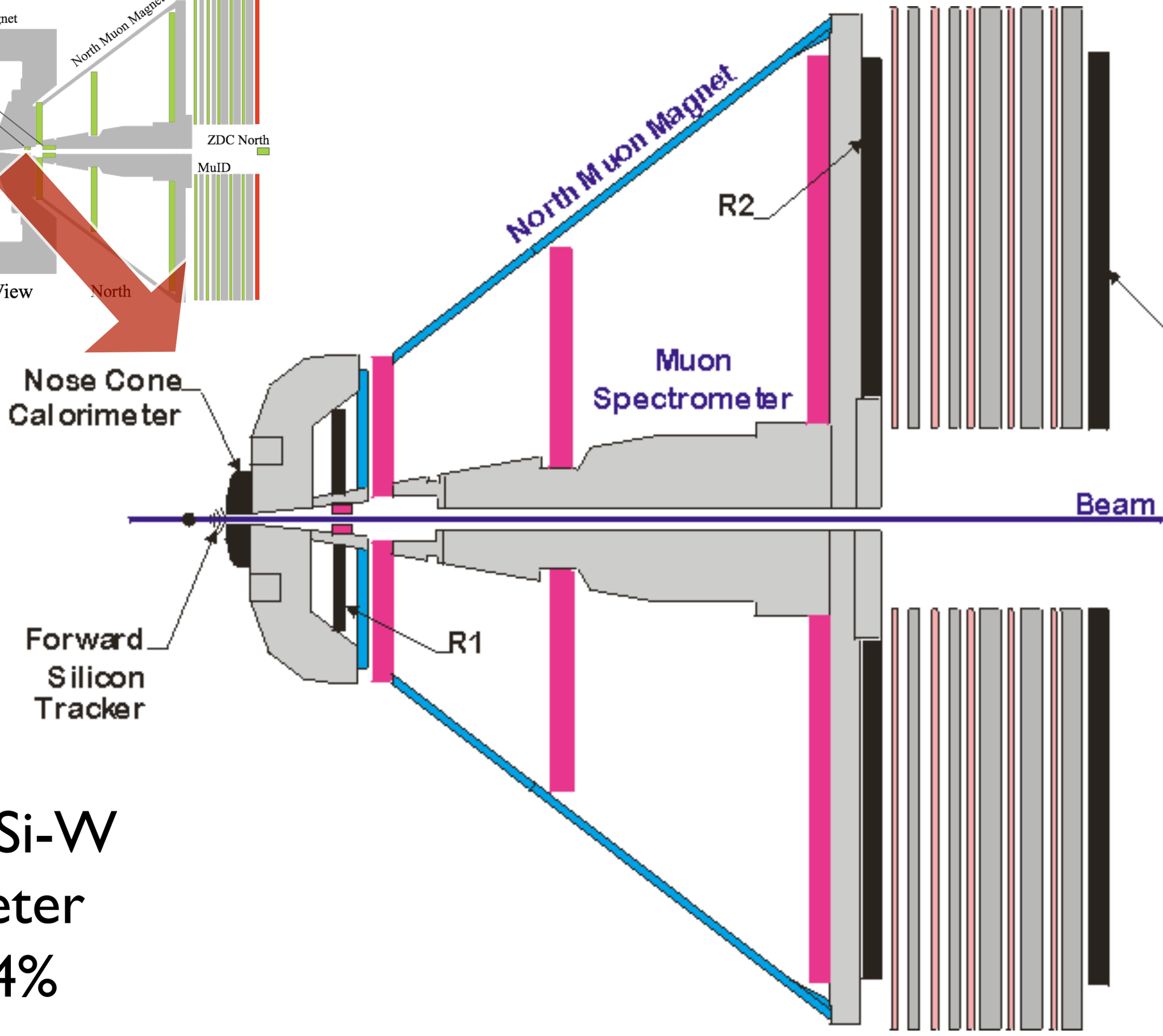
Lines of constant electron angle (ϑ'_e)




PHENIX


h,γ,e spectrometer
excellent muon spectrometer
beam line
(not so excellent for electrons)





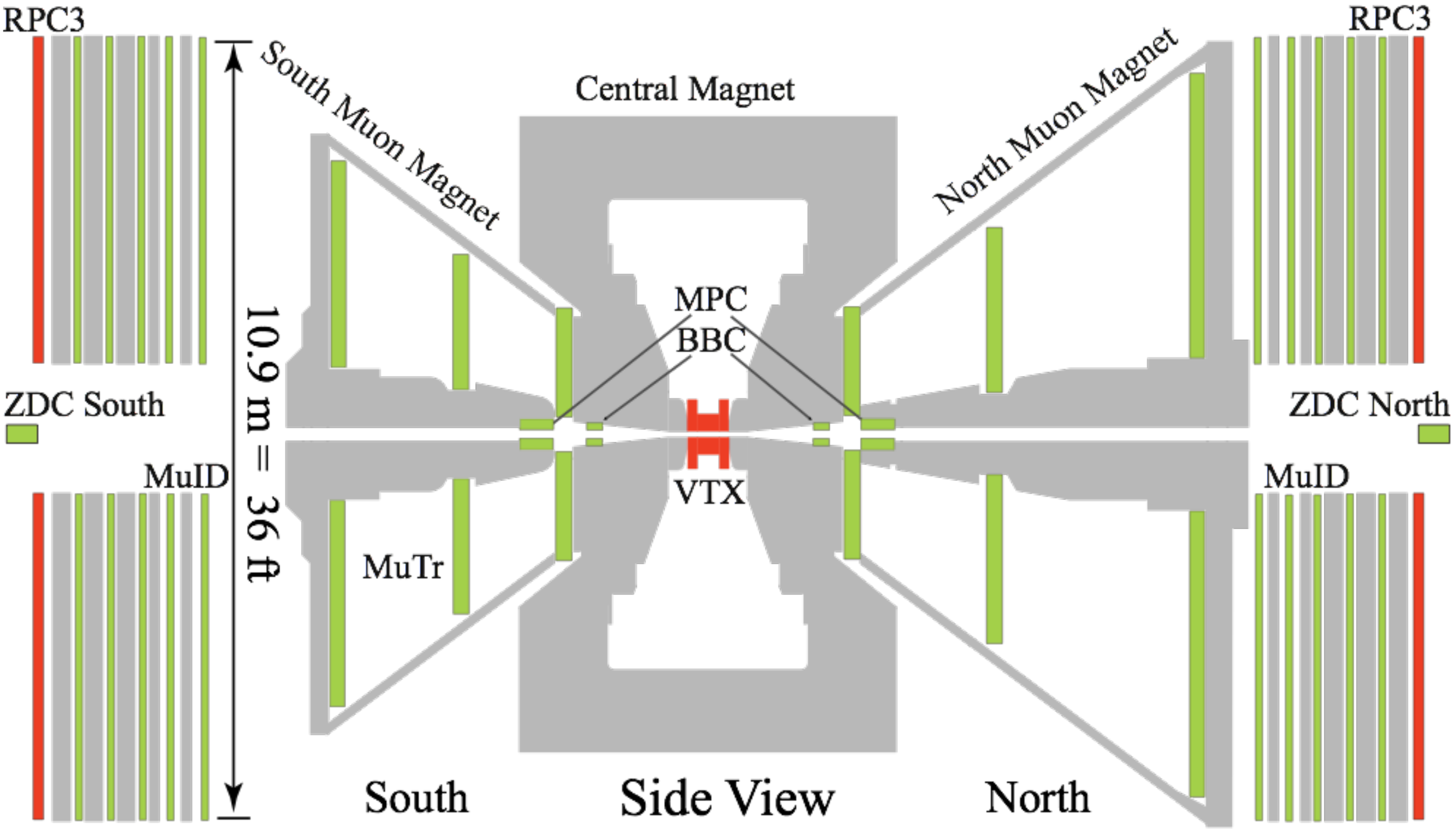
compact Si-W calorimeter

$\sigma_E \sim 24\%$

Charge from Steve Vigdor concerning decadal plans

2) The compelling science goals you foresee for RHIC A+A, p+p, and d+A collisions that can only be carried out with additional upgrades (or replacements) of detector subsystems or machine capabilities (e.g., further luminosity or diamond size improvements). For each such goal, provide some explanation of why RHIC is the appropriate facility (e.g., in competition with LHC or FAIR) to pursue that science, and preferably some simulations that demonstrate the need for new detector or machine capabilities to address the compelling questions. If the pursuit of some science goals is conditional on results to be obtained over the next several years, try to outline the decision points you foresee for deciding future paths.

4) Any plans or interest your Collaboration has in adapting your detector or detector subsystems (or detector R&D) to study electron-nucleon and electron-ion collisions with an eventual eRHIC upgrade. This is relevant only near the end of the decade addressed here, but will be important for planning purposes. (We may well be forced by financial or environmental considerations, even for a first MeRHIC stage, to consider options in which acceleration of the electron beam is carried out around the RHIC tunnel, requiring some scheme for getting an electron beamline through or around PHENIX and STAR. So it is worth considering if there is some way you could make use of the e-p and e-A collisions if we provided them.)


RPC3
South Muon Magnet
Central Magnet
North Muon Magnet
RPC3
MPC
BBC
ZDC South
ZDC North
10.9 m = 36 ft
MuID
VTX
MuID
MuTr
South
Side View
North

RPC3

RPC3

North Muon Magnet

RICH

PbSc

η = 1

2m

η = 2

η = 3

η = 4

80cm

40cm

10cm

(F)VTX

Tracker

PreShower

EMCal

Solenoid

HCal

ZDC South

ZDC North

MuID

MuID

PreShower

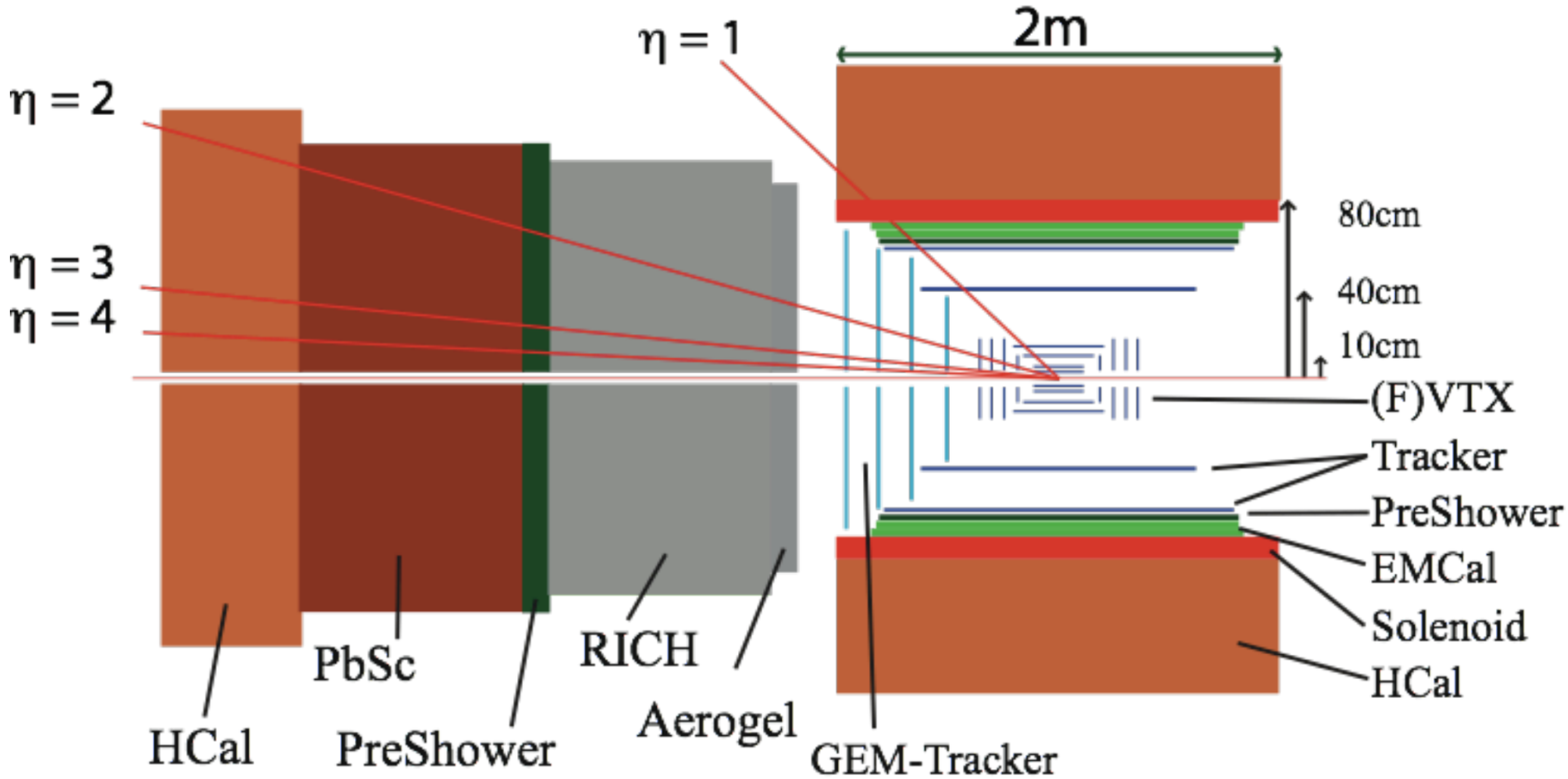
HCal

Aerogel

Side View

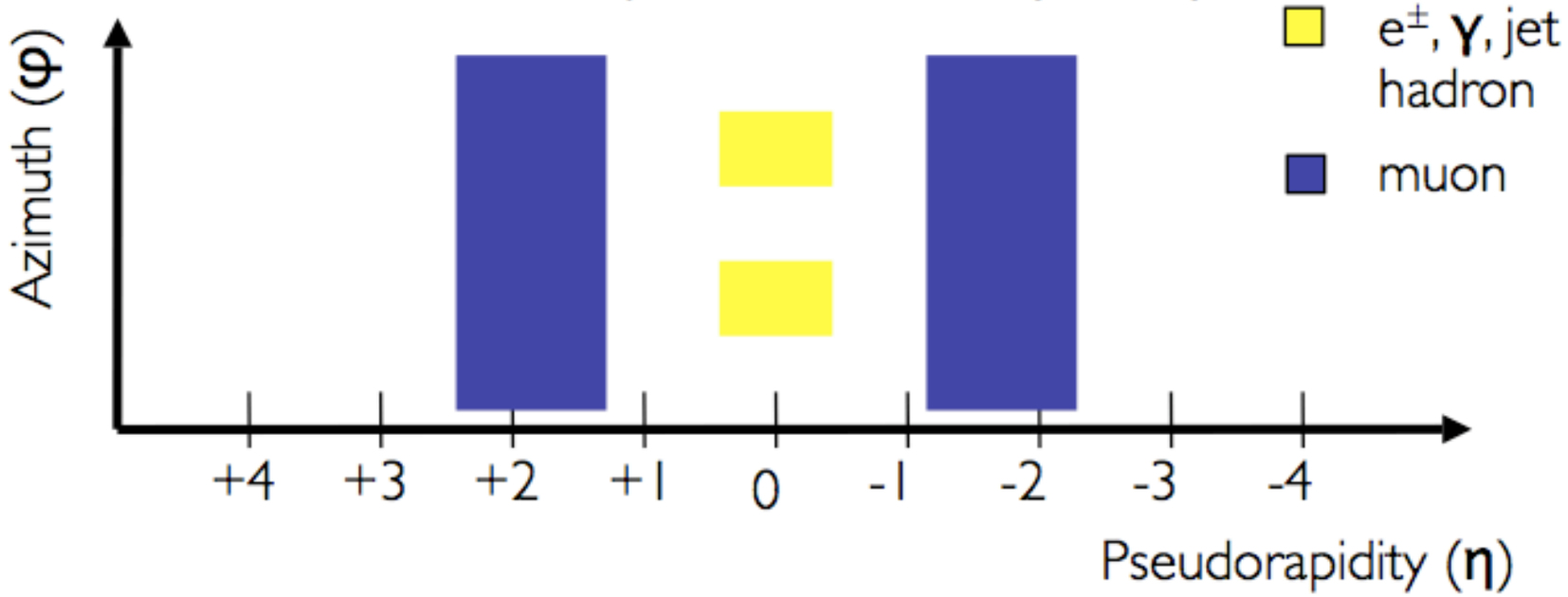
North

sPHENIX/ePHENIX strawman

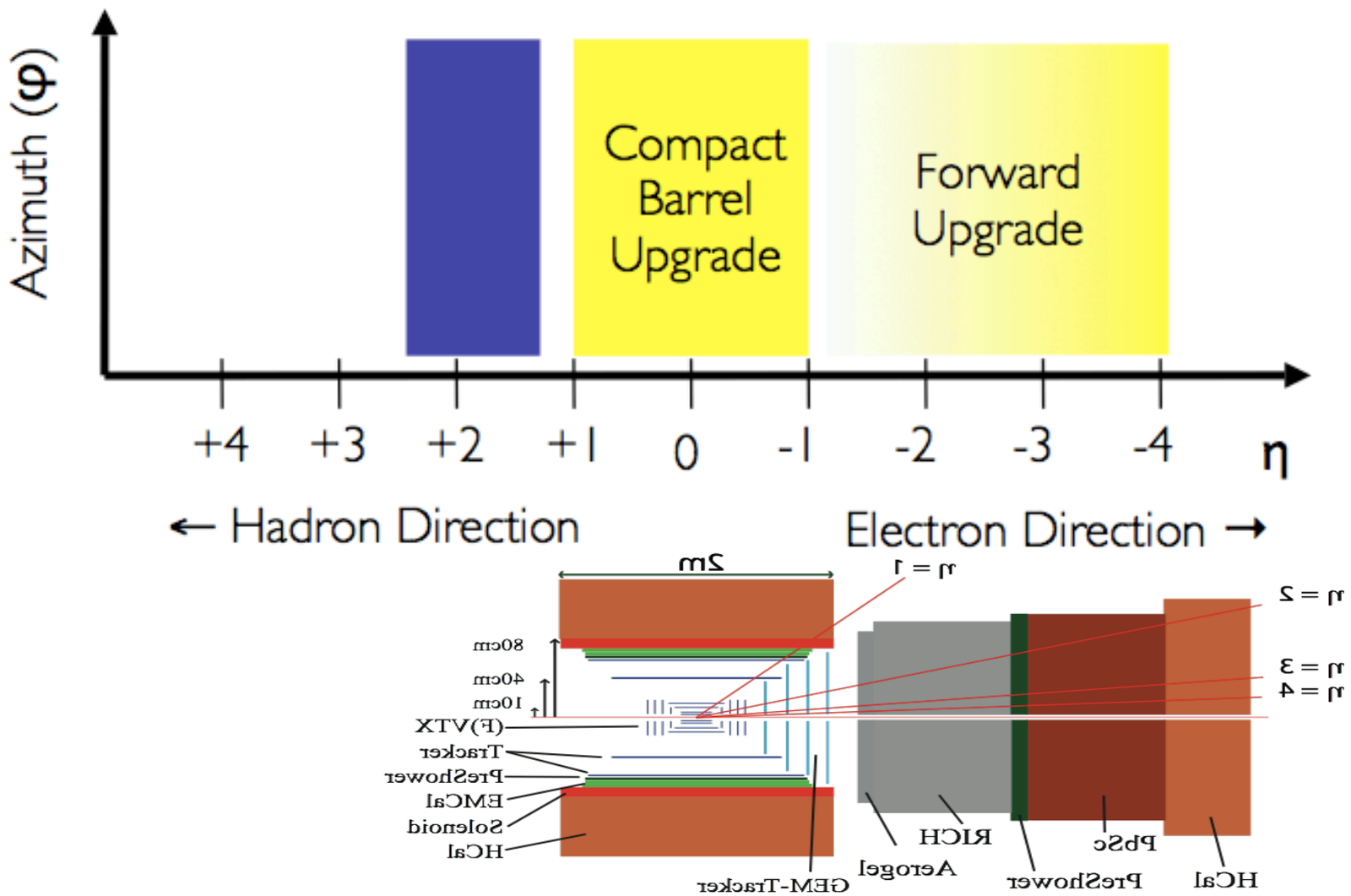


dimensions, technology, additional capabilities still under investigation

PHENIX Spectrometer (2010)



sPHENIX Upgrade



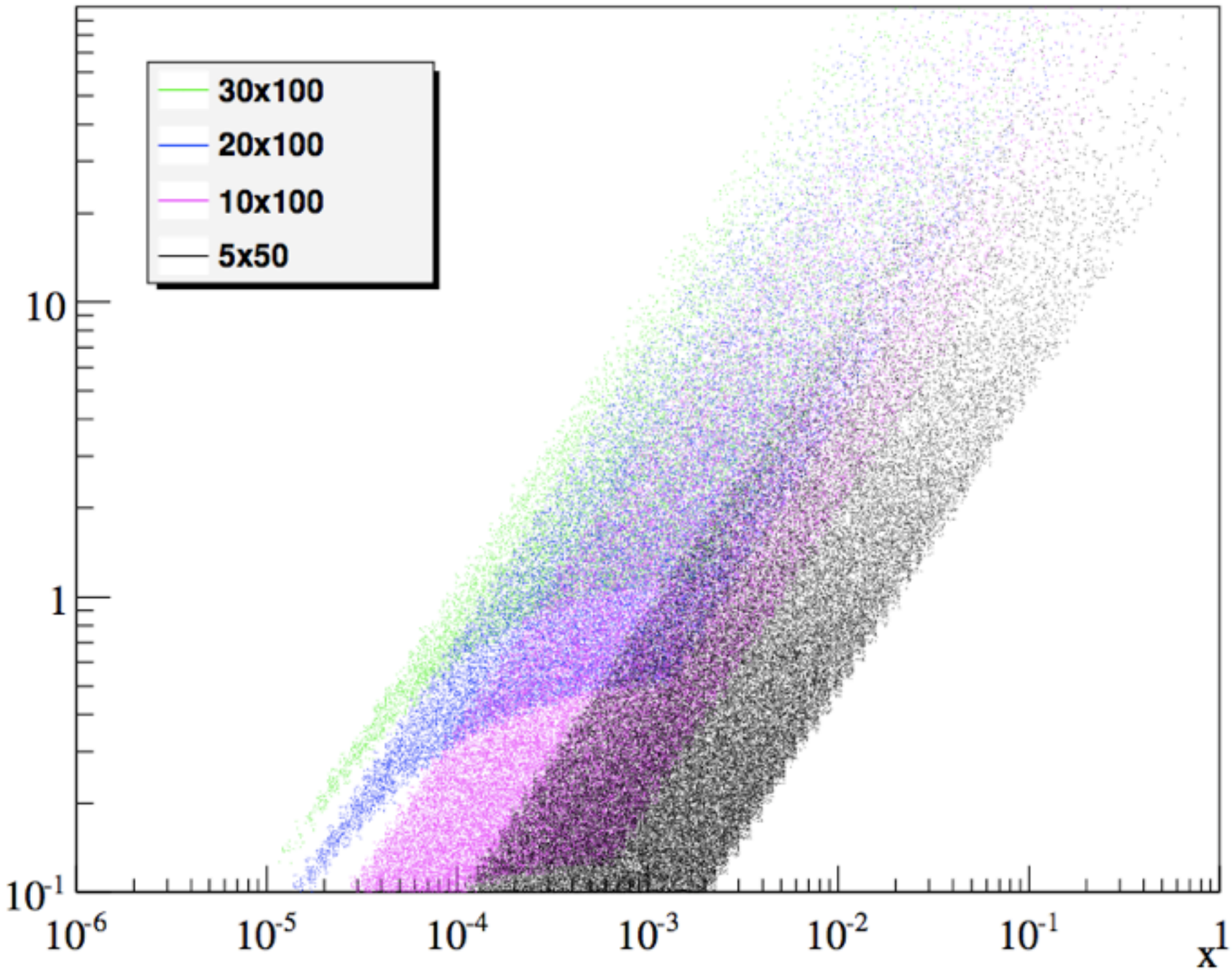
- Inclusive e+p physics to measure polarized and unpolarized structure functions. For the polarized case, these measurements will significantly advance our knowledge of the contributions of quarks and gluons to the proton spin.

- Inclusive e+A physics to measure unpolarized structure functions and derive nuclear parton distribution functions nPDFs. These measurements are particularly relevant to studies of gluon saturation effects.

- Elastic diffractive physics, i.e. elastic vector meson production and deeply virtual Compton scattering (DVCS). In e+p a tomographic picture of the proton will become possible, while diffractive e+A pins down the initial state for heavy ion collisions. Most of the measurements require the addition of "Roman pot" detectors.

PHENIX Decadal Plan, Chapter 8,
"ePHENIX Physics Plan for the Electron Ion Collider"
http://www.phenix.bnl.gov/plans.html

Q^2 vs x for e+A



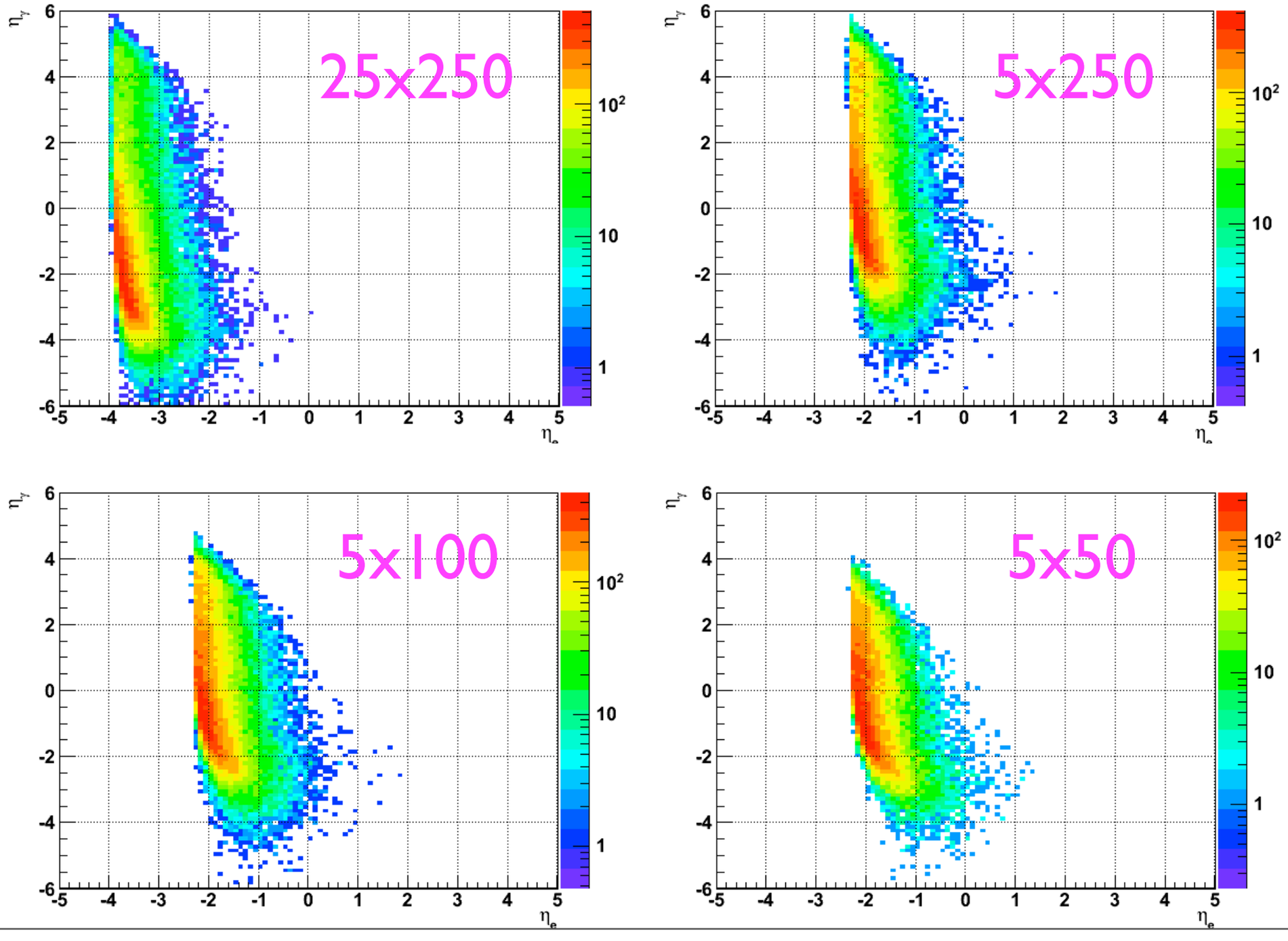
$0.05 < y < 0.9$; $-4 < y_e < 1$

e+p→e+p+γ

Study of DVCS considerations by J. H. Lee

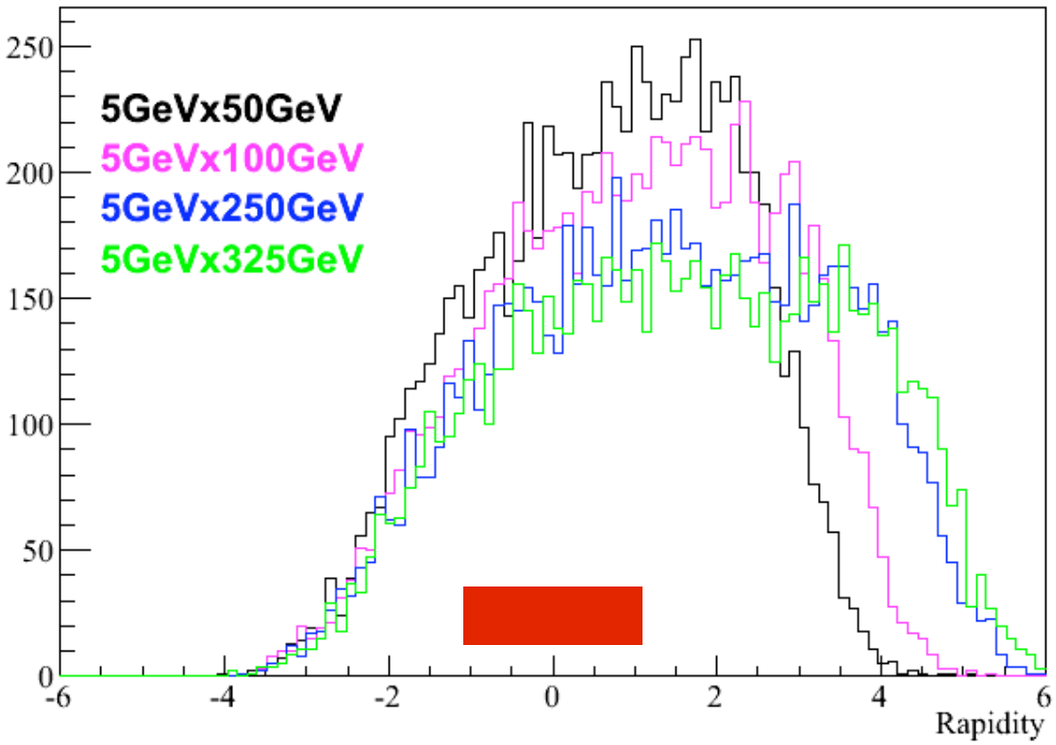
η_γ vs η_e with "RP" accepted events

"Roman Pots"

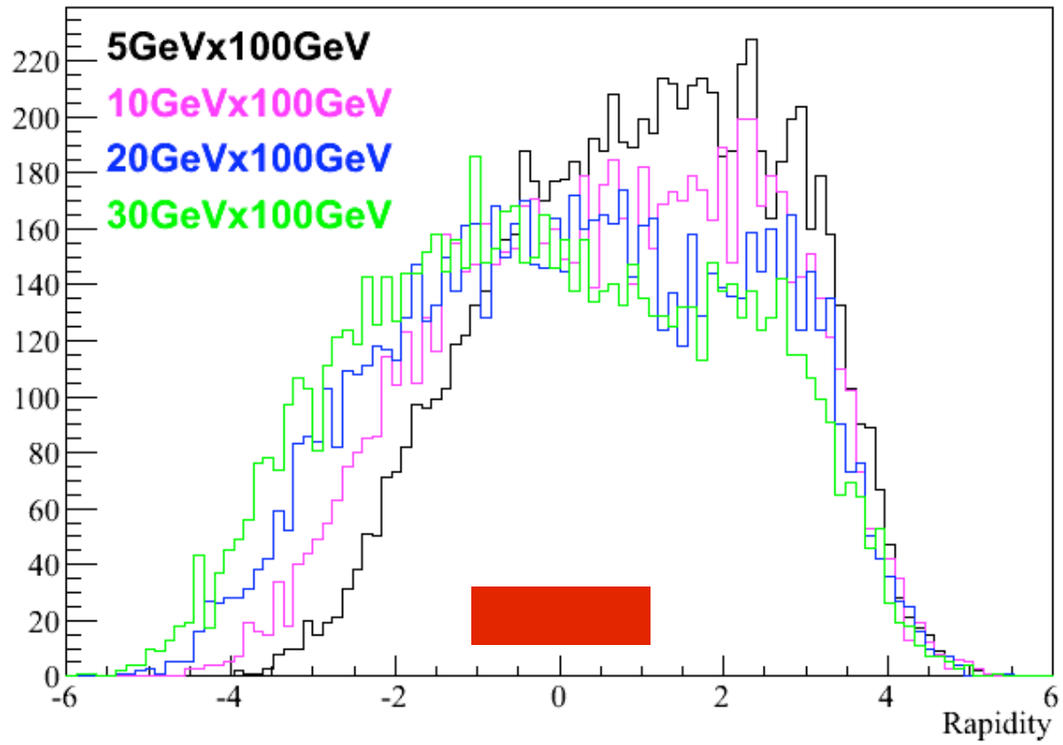


Uses the DVCS generator MILOU (hep-ph/0411389)

$\pi^{\pm}$ from ρ^0



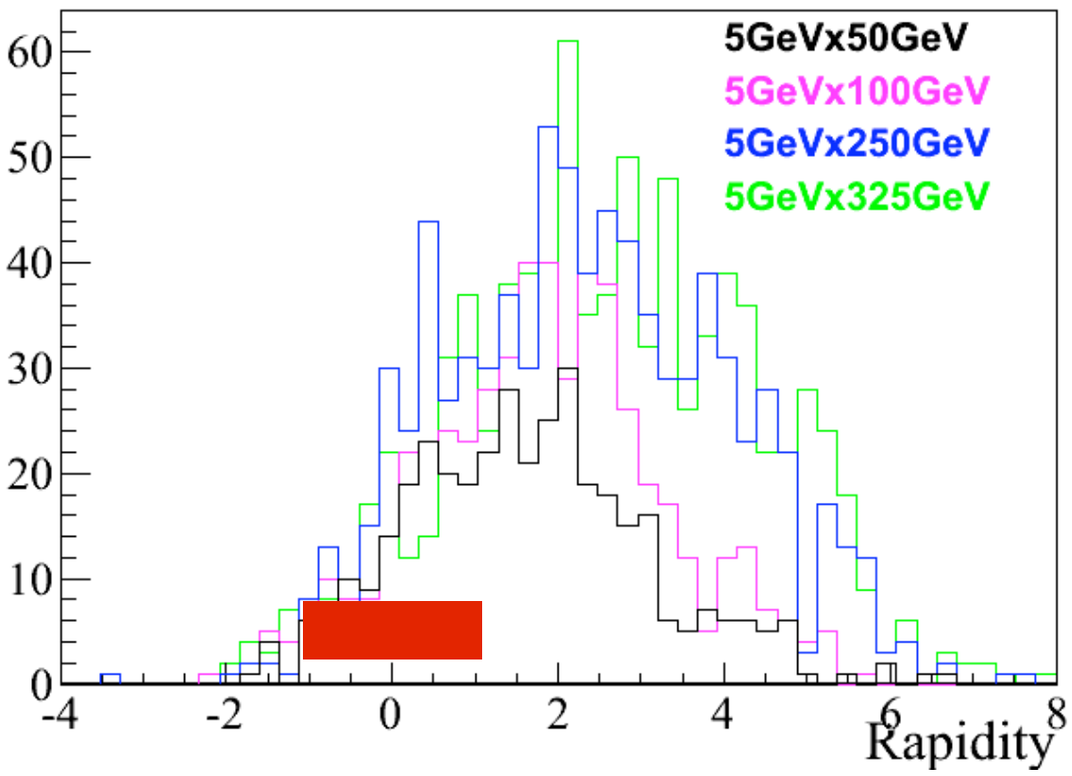
$e^{\pm}$ from J/ψ

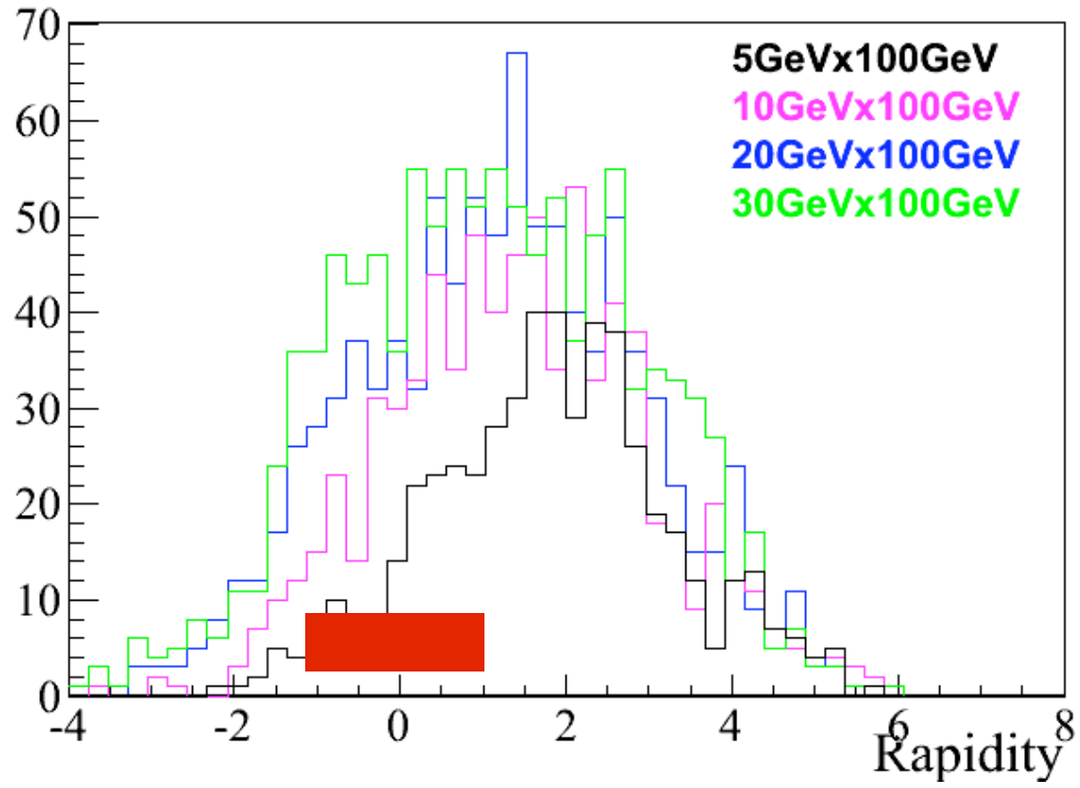


MS: constrain quark GPD

charm structure function $F_2^c(x,Q^2)$

leptons from charm





to the extent that charm content is due to gluon splitting
$F_2^c(x,Q^2)$
is a more direct probe of gluon distribution in nucleus (nucleon) than
$F_2(x,Q^2)$

Brodsky and Vogt, Nucl. Phys., B438:261–277, (1995)

longitudinal spin structure of nucleon via DIS (and SIDIS)

gluon distribution in nucleons and nuclei via low-*x* inclusive and diffractive scattering

ePHENIX

three-dimensional landscape of the nucleon through measurement of GPDs

electroweak physics at high *x* and high Q^2

PHENIX has been busy

- three day upgrade R&D meeting in Dec.
- weekly meetings on decadal plan, e.g.:
  - forward magnetic field
  - forward momentum resolution
  - capabilities for EM probes in barrel
  - PID needs in forward/barrel

Calorimetry - Tuesday Dec. 14, 2010

Calorimetry - Tuesday Dec. 14, 2010

- Conveners: Craig Woody (woody@bnl.gov), Edward Kistenev (kistenev@bnl.gov)
- This is the first in the series of the PHENIX Decadal Upgrade Workshops (Uplink)

- **Agenda Draft:**
  - start at 8:30 am
- 10' – Introduction to the Workshop and Calorimetry Session (M.Leitch pptx, pdf; C.Woody ppt, pdf)
  - 30' – Overview of the PHENIX Decadal Plan (D.Morrison, pdf)
  - 20' – Physics with Calorimetry in the PHENIX Upgrade (M.McCumber, pdf)
  - 20' - Calorimeter Requirements – What's in the Decadal Plan ? (N.Grau, pdf)
  - 20' - Technology Choices for Calorimetry in an Upgraded PHENIX Detector (C.Woody ppt, pdf)
  - 30' - Status of Physics Analysis with the Current PHENIX EMCAL (T.Sakaguchi, pptx, pdf)
  - 30' - The ALICE FOCAL (T.Gunji pdf, pptx)
  - 30' – ORNL Approaches to the ALICE FOCAL & Ties to Future PHENIX Upgrades (C.Britton ppt , pdf)
  - 20' – Open mike (All) pdf
  - Lunch 12:00 pm – 1:00 pm
  - 30' - Hybrid Calorimetry in an Upgraded PHENIX (E.Kistenev, ppt)
  - 30' - Scintillator Calorimetry for the PHENIX Upgrades (J.Frantz, pptx, pdf)
  - 30' - New Technologies for SciFi Calorimeters (O.Tsai, pptx, ppt)
  - 30' - Use of SiPMs in the GlueX Barrel Calorimeter (E.Smith, pdf)
  - 30' - The CALICE Calorimeters (F.Sefkow) pdf
  - Physics Colloquium: 3:30 pm – 4:30 pm (P.Steinberg)
  - Open Discussion, Summary and Future Plans: 4:45 pm – 6:00 pm

Tracking - Wednesday Dec. 15, 2010

Tracking - Wednesday Dec. 15, 2010

- Conveners: Tom Hemmick (hemmick@skipper.physics.sunysb.edu), Rachid Nouicer (rachid.nouicer@bnl.gov)
- This is the second in the series of the PHENIX Decadal Upgrade Workshops (Uplink)

Start at 8:30 AM

- **Agenda Draft:**
  - 30' - "Silicon on Insulator (SOI) Technology", Prof. Yasuo Arai (KEK) **pdf available** One appendix: Ryo Ichimiya(KEK)**pdf available**
  - 30' - "Pixel Technology and Its Applications in STAR (HFT), CBM, ILC and ALICE", Marc Winter pdf available
  - 30' - "Simulation Tools Update", Chris Pinkenburg **ppt available**
  - 30' - "Simulation Results in the Decadal Plan", Alan Dion (BNL) **pdf available**
  - 30' - "Si Detectors in Nuclear and High Energy Physics Experiments and BNL's Detector Development and Processing Capabilities", Zheng Li (Inst. Div. BNL) **pdf available**
  - 30' - "Technology Choices of Silicon Detector at Mid- and Forward-rapidity in an Upgrade PHENIX", Rachid Nouicer (BNL) **ppt available**
  - 30' - Open mike morning session (All)

Lunch 12:00 pm – 1:30 pm

- 30' - "Recent Developments in Gas Detector Technologies: Possible Applications in PHENIX", Klaus Dehmelt (SBU) **pdf available**
- 30' - "The STAR Forward GEM Tracker - R&D, Design and Assembly", Bernd Surrow (MIT) **pdf available**
- 30' - "Large Area GEM Detector Development", Marcus Hohlmann (FIT) **pdf available**
- 30' - "Front-end ASIC for micropattern detectors", Gianluigi Degeronimo (inst. Div. BNL) **ppt available**
- 30' - "Chevron Pad Designs for Gas Trackers", Bo Yu (Inst. Div. BNL) **ppt available**
- 30' - "Open Discussion, Summary and Future Plans" (All)

PID - Thursday Dec. 16, 2010

PID Upgrades Workshop - Thursday Dec. 16, 2010

- RACF/ITD Seminar Room (next to M2-40 at top of stairs in bldg 515)
- EVO remote access will be available (EVO info)
- Conveners: Mickey Chiu (chiu@bnl.gov), Elke Aschenauer (elke@rcf2.rhic.bnl.gov)
- This is the third in the series of the PHENIX Decadal Upgrade Workshops (Uplink)
- All talks are 30 minutes plus 10 minutes for discussion. The times given are in Eastern Standard Time (NYC time).

- **Agenda:**
  - 8:30 - 9:10 Polarized p+p, dA and EIC Physics with PID ppt, pptx - Elke Aschenauer, BNL (30+10min)
  - 9:10 - 9:50 Heavy Ion Physics with PID - ppt Tatsuya Chujo, Tsukuba (30+10min)
  - 9:50 - 10:30 Latest advances in MRPC's for Fast Timing pdf - Crispin Williams, CERN (30+10min)
  - 10:30 - 11:10 Photonis MCP-PMT and Fast Waveform Digitizer Studies at BNL pdf - Mickey Chiu, BNL (30+10min)
  - 11:10 - 11:50 Compact RICH pdf - Nikolai Smirnov, Yale (30+10min)
- Lunch
  - 1:00 - 1:40 Belle DIRC pdf - Gary Varner, Hawaii (30+10min)
  - 1:40 - 2:20 Large Area Picosecond Photodetectors Project pdf - Kurtis Nishimura, Hawaii (30+10min)
  - 2:20 - 3:00 High Rate Very Fast Timing detector R&D at the BNL ATF pdf, pdf1, pdf2 - Sebastian White, BNL (30+10min)
- Open mike session + discussion
  - Hadrons at Forward Rapidity, Paul Stankus ppt, pdf
  - Workshop and Discussion Notes

If charge to RHIC expts were expanded ...

- asymmetric IP or longer, stronger magnet?
- remove other muon arm?
  - concern about albedo background
- calorimetry in hadron direction?
  - see rapidity gap for diffractive DIS

... plan for optimizing whole facility evolution

Summary

- ePHENIX is an important part of the PHENIX decadal plan
- strong capabilities for many early stage eRHIC observables – aligned with main eRHIC thrusts
- if charge to RHIC expts. is expanded, there are reasonable modifications to ePHENIX
- lots of activity in PHENIX on physics questions, technology, and strategy.